Research and Technologies for Society and Industry IEEE RTSI 2019

Firenze, Italy, September 9-12 2019

Tutorial Program

Monday September 9	11:15 – 12:30	Tutorial 1 **Impact of Equipment and System Reliability on Project Economic Optimization** Dr. Giancarlo Guenzi Managing Director of Energoconsult, Novara – Italy
Tuesday September 10	9:00 – 11:00	Tutorial 2 **Unlocking new Dimensions in Radio-based Positioning "5G Localization"** Prof. Henk Wymeersch Professor in Communication Systems with the Department of Electrical Engineering at Chalmers University of Technology, Sweden.
Tuesday September 10	17:00 – 18:15	Tutorial 3 **Complex-valued neural networks and their applications to smart technologies for industry** Prof. Igor Aizenberg Professor of Computer Science and Chair of the Department of Computer Science at Manhattan College (Riverdale, NY)
Wednesday September 11	09:00 – 10:30	Tutorial 4 **Reliability Assessment of Renewable Energy Based Generation Systems** Prof. Yasser G. Hegazy Professor of electrical engineering and the president of the German University in Cairo (GUC)
Thursday September 12	9:00 – 10:30	Tutorial 5 **Spintronic Sensors for Medical and Industrial Applications** Prof. Hadi Heidari Professor at School of Engineering and lead of the Microelectronics Lab (meLAB) at the University of Glasgow, Scotland.

Tutorial Presentation

Tutorial 1

Impact of equipment and system reliability on project Economic optimization

Speaker

Dr. Giancarlo Guenzi

Managing Director of Energoconsult, Novara – Italy

Summary

The evaluation of industrial projects is usually carried out trying to reach an optimization / compromise between the performance and what are considered the overall costs along the project life; conversely, reliability aspects are often taken into account only once that the plant configuration and the budget have been identified, and this rarely leads to a sound optimization. In general, reliability and performance are considered as opposite to cost; the solution is to reach an optimization that can be: - Maximum reliability at a prefixed cost, or - Minimum cost at a prefixed reliability level The reliability-cost optimization is a basic topic in the assessment of large systems, and some books, or chapters of books, have been dedicated to this subject. However, it has to be pointed out that all the methodologies introduced by the above books and papers are mainly focused on specific aspects, and often related to the comparison of possible alternatives; in other words, the approach is usually "Top-Down", i.e. deductive starting directly from a set of possible solutions. This is too directly oriented to the solutions themselves, and therefore intrinsically limited, while a "Bottom-Up" deductive methodology, starting from the analysis of components and simple systems, suitable to set generalized criteria, should be more appropriate. For the above reasons, it has been decided to develop and propose this new methodology, starting "Bottom-Up" from the lower level, i.e. from the components and simple systems, in order to identify general rules for reliability-cost relations and for their interdependencies. It is a new generalized approach, suitable to be adopted for any kind of industrial system, and self-standing at equipment level and for limited systems. For the reliability analysis of large systems, this methodology is proposed as the necessary starting point, i.e. the complementary analysis for the deductive (Top- Down) approach, with the possibility to reach more objective results.

The Tutorial covers the optimization of the investment of large systems / plants, as a balance between reliability, costs, life cycle costs and incomes. The Tutorial will be organized in four Chapters: the first one is refreshing basic Probability / Reliability concepts, the other chapters cover the reliability / cost optimization and are based on previously published papers.

Brief CV of the speaker

Giancarlo Guenzi was born in Italy on 1946. He received a MSc equivalent degree in Electrical Eng. - Power Plants from Politecnico di Milano, a MSc in Electrical Eng. - Power Systems Analysis from USP - São Paulo, MSc and PhD – Doctor of Philosophy in Reliability Engineering from University of Maryland; furthermore, he is Certified Cost Engineer AICE – ICEC A, Life Senior Member IEEE, and Professional Engineer in Novara – Italy. For his contribution to Cost Engineering, mainly in the area of Feasibility / Reliability / Cost Evaluation, ICEC - International Cost Engineering Council recognized him on 2018 as Distinguished International Fellow (DIF). He is Managing Director of Energoconsult, Novara – Italy, in charge of risk and reliability analysis, power systems design and analysis, cost engineering studies. He is author / co-author of more than 35 papers covering reliability and risk analysis, cost engineering, ground grids, protection systems.

Tutorial 2

Unlocking new Dimensions in Radio-based Positioning "5G Localization"

Speaker

Prof. Henk Wymeersch

Professor in Communication Systems with the Department of Electrical Engineering at Chalmers University of Technology**.**

Summary

The tutorial intends to provide electrical engineers with the necessary tools to include the positioning functionality in the design and analysis of communication systems. The objective of the tutorial is to describe models, theoretical bounds, and algorithms that serve to exploit the 5G technologies also for positioning services.

Positioning of devices using radio-frequency signals is a long-standing topic, and many systems have been used or specifically designed for this objective. Examples include LORAN-C and GPS for outdoor positioning, as well as ultra-wide band and WiFi for indoor positioning. Even though cellular systems could have had the advantage of offering a low-cost localization solution, up to the current generation (4G), they have never been an attractive solution for positioning due to their low accuracy. Consequently, their main application has been limited to the (mandatory) localization of emergency calls. The situation can change drastically with 5G. Thanks to 5G proposed technologies (use of large carrier frequencies, large antenna arrays and network densification), and if the localization functionality is considered at due time in the design, 5G systems can be the first generation offering high-accuracy localization and orientation, together with high coverage while maintaining low cost because the communication infrastructure is used. Hence, it is important for researchers to be aware of this opportunity. Moreover, 5G systems will offer a natural and tight connection between localization and communication, where each of two functionalities will benefit from the other. This tutorial will also contribute to creating links between a broad spectrum of topics, from those more related to communications such as throughput, beam alignment, channel estimation, etc. to those closer signal processing and positioning such as channel modeling for positioning, compressed sensing, estimation bounds for positioning, tracking and mapping.

Brief CV of the speaker

Henk Wymeersch is a Professor in Communication Systems with the Department of Electrical Engineering at Chalmers University of Technology, Sweden. He is also affiliated with the FORCE research center on fiberoptic communication, and was the PI of COOPNET, an ERC project on cooperative networks. Prior to joining Chalmers, he was a Postdoctoral Associate during 2006-2009 with the Laboratory for Information and Decision Systems (LIDS) at the Massachusetts Institute of Technology (MIT). Henk Wymeersch obtained the Ph.D. degree in Electrical Engineering/Applied sciences in 2005 from Ghent University, Belgium. For his thesis, he received the 2006 Alcatel Bell Scientific Award. He received a fellowship from the Belgian American Educational Foundation in 2005-2006. He is a member of the IEEE and served as Associate Editor for IEEE Transactions on Communications (2016-present), IEEE Transactions on Wireless Communications (2013-2018), for IEEE Communication Letters (2009-2013). He served as Guest Editor for IEEE Journal on Selected Areas in Communications (JSAC, special issue on Location-aware Radios and Networks), EURASIP Journal on Wireless Communications and Networking (special issue on Localization in Mobile Wireless and Sensor Networks), and for EURASIP Journal on Advances in Signal Processing (special Issue on Signal Processing Techniques for Anywhere, anytime positioning). In 2015, he served as General Chair of the International Conference on Localization and GNSS.

Tutorial 3

Complex-valued neural networks and their applications to smart technologies for industry

Speaker

Prof. Igor Aizenberg

Professor of Computer Science and Chair of the Department of Computer Science at Manhattan College (Riverdale, NY)

Summary

Due to the computational and theoretical advantages that processing in the complex domain offers over the real-valued domain, the area of complex-valued neural networks is one of fastest growing research areas in the neural network community. In addition, recent progress in pattern recognition, robotics, mathematical biosciences, brain-computer interface design has brought to light problems where nonlinearity, multidimensional data natures, uncertainty, and complexity play major roles – complex-valued neural networks are a natural model to account for these applications.

The multi-valued neuron (MVN) is a complex-valued neuron whose inputs are arbitrary complex numbers and whose output is located on the unit circle. MVN has a circular activation function, which depends only on phase and projects a weighted sum onto the unit circle. These specific properties determine many unique advantages of MVN. The most important of them are the ability of MVN to learn non-linearly separable input/output mappings without any network and simplicity of derivative-free learning, which is based on the error-correction rule.

The multilayer feedforward neural network with multi-valued neurons (MLMVN) significantly outperforms a classical multilayer perceptron (MLP) and many kernel-based techniques including SVM in terms of its generalization capability and the number of parameters employed. MLMVN learns faster than a number of other machine learning tools. Its learning is derivative-free and based on the highly efficient batch algorithm.

Complex-valued neural network models and MLMVN in particular have been shown not only to exhibit enhanced accuracy, but also to facilitate physical interpretation of their variables.

The synergy of complex nonlinearity, circularity, the ability to separate linearly those mappings, which are not separable in the real domain, underpins this tutorial, which aims at providing a rigorous unifying framework for the design, analysis, and interpretation of complex neural network models.

We will illustrate applications of MLMVN by a number of examples, such as cloud datacenter workload prediction, oil well productivity prediction, turnout degradation prediction and intelligent image analysis. We will also demonstrate how MLMVN can be used for simulation of hybrid systems.

Brief CV of the speaker

Dr. Igor Aizenberg has been working in the area of complex-valued neural networks and their applications for the last 30 years. Since 2016 he is Professor and Chair of the Department of Computer Science at Manhattan College, New York, USA. In 2006-2016 he was Professor at Texas A&M University-Texarkana (USA). Before that he worked in Ukraine, Russia, Belgium, Germany, and Finland. His work on complex valued neural networks has widely published. He is the author of more than 20 journal papers and two books. He is also a Vice-Chair of the Complex-Valued Neural Networks Task Force of the IEEE Computational Intelligence Society Technical Committee. Dr. Aizenberg served as a Visiting Professor at the National Institute of Advanced Industrial Science and Technology (Japan), University of Zaragoza (Spain), University of Nis (Serbia), Polytechnic of Porto (Portugal), National Sun Yat Sen University (Taiwan), Masaryk University (Brno, Czech Republic), Uzhhorod National University (Ukraine). His research interests include complex-valued neural networks, learning algorithms, intelligent image processing and pattern recognition.

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Tutorial 4

Reliability Assessment of Renewable Energy Based Generation Systems

Speakers

Prof. Yasser G. Hegazy

Professor of electrical engineering and the president of the German University in Cairo (GUC)

Summary

Renewable energy sources are regarded as the main sources of clean, affordable and efficient electricity worldwide. Wind and solar energies represent the lowest environmental risk and most established renewable technologies due to their recent technical developments and financing options. However, wind and solar based power generators are considered time dependent sources as the amount of electrical power produced from these generators depends on several natural random variables such as wind speed and solar irradiance. Therefore, the assessment of the reliability of these generation systems taking into considerations the stochastic variation of this power is a challenging task. In this tutorial, a general procedure for assessing the reliability indices of systems supplied by wind or photovoltaic generators will be covered in details. The tutorial will introduce the integration of the state duration sampling approach and sequential Monte Carlo simulation with Markov Chain rules to estimate the power production of stand-alone or grid connected photovoltaic or wind based power stations and will show how calculate the system reliability indices accordingly.

Brief CV of the speakers

Yasser G. Hegazy, received the B.Sc. and M.Sc. degrees in electrical engineering from Ain shams University, Cairo, Egypt, in 1986 and 1990, respectively, and the Ph.D. degree in electrical engineering from the University of Waterloo, Waterloo, ON, Canada, in 1996. Currently, he is a Professor of electrical engineering and the president of the German University in Cairo (GUC). Professor Hegazy has a solid international publication record in the fields of power system reliability, distributed generation, and power quality. He is a senior member of IEEE power and energy society and a reviewer of IEEE transactions in power systems, power delivery and energy conversion. Prof. Hegazy received the 2004 State encouragement award in Engineering Sciences from the Egyptian academy for science and research and the IEEE PES chapter, outstanding engineering award 2016.

Tutorial 5

Spintronic Sensors for Medical and Industrial Applications

Speaker

Prof. Hadi Heidari

Assistant Professor at School of Engineering and lead of the Microelectronics Lab (meLAB) at the University of Glasgow, Scotland.

Summary

In recent years, an enormous surge of works is being carried out on developing new methods towards integrated sensing devices of various kinds of applications ranging from medical diagnostics, implantable electronics to brain-like computers. Implementation of such microsystems using conventional CMOS technology is inefficient in terms of area, performance and power. Such inefficiencies have driven a significant effort to investigate the development of highly sensitive beyond-CMOS devices. Thin-film Spintronics implementation provides an opportunity to produce and optimise powerful and low-power devices for various sensing and computing applications. The tutorial will introduce our research at the Microelectronics Lab (meLAB) in microelectronics and magnetic sensors with several different works addressing the development of architectures for the implementation of efficient biomedical and neuromorphic electronics based on emerging Spintronic sensing technologies. This tutorial covers developments and trends in the magnetic sensing devices including sensors and circuit Interfaces focusing on the development of spintronic sensors including giant magnetoresistances (GMR) and Tunnelling Magnetoresistive (TMR). Before that, various types of other magnetic sensors involving Hall-effect, Magnetoelectric (ME) and Nuclear Magnetic Resonance (NMR) technologies will be presented. The tutorial will also present various approaches for obtaining highly sensitive magnetic sensing and computing devices including magnetic tunnel junctions and spin Hall nano-oscillators. Furthermore, the exploit of spintronic sensors for medical diagnostics, brain-machine interface and neuromorphic chips will be discussed comprehensively. This will be followed by various alternatives for higher performance electronics including heterogeneously structure with combining the CMOS circuitry interface and non-CMOS sensors. At the end of tutorial, some applications such as magnetomyography for capturing the magnetic field from the skeletal muscle will be presented. The lectures in this tutorial will help attendees gain insight into the technical problems that must be overcome while developing magnetic sensing systems for medical and industrial applications. Tutorial on “Spintronic Sensors for Medical and Industrial Applications”

Brief CV of the speaker

Hadi Heidari (PhD, SMIEEE) is an Assistant Professor (Lecturer) in the School of Engineering and lead of the Microelectronics Lab (meLAB) at the University of Glasgow, Scotland. Dr Heidari is a member of the IEEE Circuits and Systems Society Board of Governors (2018- 2020), IEEE Sensors Council Member-at-Large (2020-2021) and Senior Member of IEEE. He is an Associate Editor for the IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology and IEEE Access, Editor of Elsevier Microelectronics Journal, and Guest Editor for the IEEE Sensors Journal, and Frontiers in Neuroscience. He is the General Chair of 27th IEEE ICECS 2020, Technical Program Chair of IEEE PRIME'19, and serves on the organising committee of several conferences including the UK Circuits and Systems Workshop (UKCAS), UK-China Emerging Technologies (UCET) Conference, IEEE SENSORS’16 and ’17, NGCAS’17, BioCAS’18, PRIME’15, ISCAS'23, and the organiser of several special sessions on the IEEE Conferences. His research has been funded by major research councils and funding organizations including the European Commission, EPSRC, Royal Society and Scottish Funding Council. He is part of the €8.4M EU H2020 FET-Proactive project on “Hybrid Enhanced Regenerative Medicine Systems (HERMES)”. Dr Heidari has authored/co-authored over 100 peer-reviewed publications in tier-1 journals or conference proceedings and acts as a reviewer for several journals and conferences. He has been the recipient of a number of awards including the Rewards for Excellence prize from the

University of Glasgow (2018), IEEE CASS Scholarship (NGCAS'17 conference), Silk Road Award from the Solid-State Circuits Conference (ISSCC'16), Best Paper Award from the IEEE ISCAS'14 conference, Gold Leaf Award from the IEEE PRIME'14 Conference. He was a research visitor with the University of Macau, China, and McGill University, Canada.